



(51) International Patent Classification:
D21G 1/00 (2006.01)

(21) International Application Number:
PCT/FI2009/050433

(22) International Filing Date:
25 May 2009 (25.05.2009)

(25) Filing Language: Finnish

(26) Publication Language: English

(30) Priority Data:
20085546 4 June 2008 (04.06.2008) FI

(71) Applicant (for all designated States except US): **METSO PAPER, INC.** [FI/FI]; Fabianinkatu 9 A, FI-00130 Helsinki (FI).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **VAITTINEN, Henri** [FI/FI]; Vihtakatu 20 C 2, FI-04400 Järvenpää (FI). **PIETIKÄINEN, Reijo** [FI/FI]; Puistotie 42 B, FI-04420 Järvenpää (FI).

(74) Agent: **LEITZINGER OY**; Tammasaarenkatu 1, — with international search report (Art. 21(3))
FI-00180 Helsinki (FI).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

(54) Title: METHOD FOR HANDLING A FIBROUS WEB IN A METAL BELT CALENDER AND A DEVICE FOR IMPLEMENTING THE METHOD

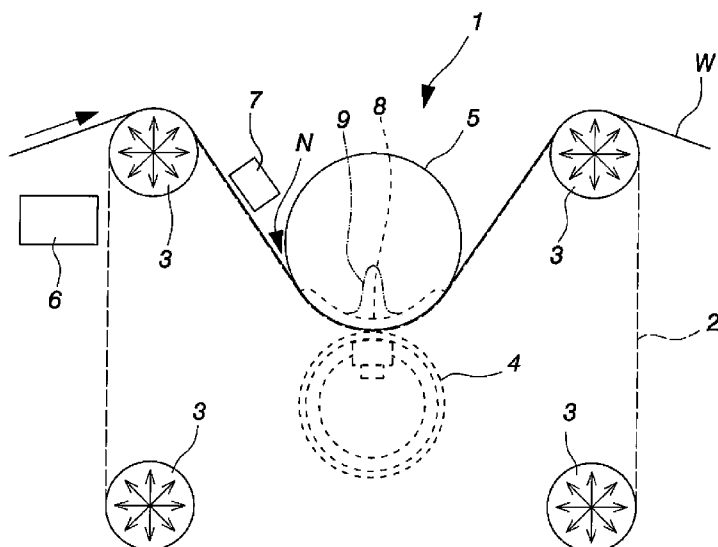


Fig. 1

(57) Abstract: The object of the invention is a method for handling a fibrous web (W) in a metal belt calender (1). In the method, an endless metal belt (2) is arranged to rotate around a guide means (3) and to form a processing zone with a counter-element (5) provided outside the metal belt (2). The fibrous web (W) is humidified at least on one side before passing it through the processing zone. In order to humidify the fibrous web (W), the humidifying agent is supplied on the surface of the fibrous web (W) 0.2-4 seconds before conveying it to the processing zone. Furthermore, 0.01-10 grams of humidifying agent per square metre is supplied, whereby subsequent to passing through the processing zone, the bulk of the fibrous web (W) is greater than 1.40 cm³/g and the PPs roughness is 2-6 µm.

Method for handling a fibrous web in a metal belt calender and a device for implementing the method

5 The present invention relates to a method for handling a fibrous web in a metal belt calender, in which method an endless metal belt is arranged to rotate around a guide means and to form a processing zone with a counter-element provided outside the metal belt, and in which the fibrous web is humidified at least on one side before passing it through the processing zone.

10

The invention further relates to a device for handling a fibrous web in a metal belt calendar, in which device an endless metal belt is arranged to rotate around a guide means and to form a processing zone with a counter-element provided outside the metal belt, and which device includes means
15 for humidifying the fibrous web at least on one side before passing it through the processing zone.

The method disclosed above and devices for implementing it are previously known, for example, from the Applicant's own Finnish patent application no.
20 20020159. In it is disclosed that the humidity regulation of the web to be processed can be carried out by methods known as such, for example, by steaming the surface/surfaces of the web before passing the web to the processing zone. By means of humidification and/or temperature regulation, the cross-direction profile of the web can be effected in the desired manner
25 and the method allows for considerable variation in web humidity.

There are numerous different paper and board grades and these can be divided into two categories on the basis of grammage: papers, which have a single layer and a grammage of 25-300 g/m², and boards made by multi-
30 layer technique and having a grammage of 150-600 g/m². As can be seen from this, the borderline between paper and board is a sliding one since

boards having the lightest grammage are lighter than the heaviest papers. Paper is generally used for printing and board for packaging.

5 The following descriptions are examples of values currently used for fibrous webs and they may vary considerably from the disclosed values. The descriptions are based mainly on the reference publication Papermaking Science and Technology, section: Papermaking Part 3, edited by Jokio, M., published by Fapet Oy, Jyväskylä 1999, 361 pages.

10 Mechanical pulp based, i.e. wood-containing, printing papers include newsprint, uncoated magazine paper and coated magazine paper.

Newsprint is composed either completely of mechanical pulp or it may contain some bleached softwood pulp (0-15%) and/or recycled fibre to
15 replace some of the mechanical pulp. As general values for newsprint may be regarded the following: grammage 40-48.8 g/m², ash content (SCAN-P 5:63) 0-20%, PPS s10 roughness (SCAN-P 76-95) 3.0-4.5 µm, Bendtsen roughness (SCAN-P21:67) 100-200 ml/min, density 600-750 kg/m³, brightness (ISO 2470:1999) 57-63% and opacity (ISO 2470:1998) 90-96%.

20 Uncoated magazine paper (SC = supercalendered) usually contains 50-70% mechanical pulp, 10-25% bleached softwood pulp, and 15-30% fillers. Typical values for calendered SC paper (including e.g. SC-C, SC-B and SC-A/A+) are: grammage 40-60 g/m², ash content (SCAN-P 5:63) 0-35%,
25 Hunter gloss (ISO/DIS 8254/1) < 20-50%, PPS s10 roughness (SCAN-P 76:95) 1.0-2.5 µm, density 700-1250 kg/m³, brightness (ISO 2470:1999) 62-70% and opacity (ISO 2470:1998) 90-95%.

Coated magazine paper (LWC = light weight coated) contains 40-60%
30 mechanical pulp, 25-40% bleached softwood pulp and 20-35% fillers and coaters. As general values for LWC paper may be regarded the following: grammage 40-70 g/m², Hunter gloss 50-65%, PPS S10 roughness 0.8-1.5

μm (offset) and 0.6–1.0 μm (roto), density 1100–1250 kg/m^3 , brightness 70–75% and opacity 89–94%.

5 As general values for MFC paper (machine finished coated) may be regarded the following: grammage 50–70 g/m^2 , Hunter gloss 25–70%, PPS S10 roughness 2.2–2.8 μm , density 900–950 kg/m^3 , brightness 70–75% and opacity 91–95%.

10 As general values for FCO paper (film coated offset) may be regarded the following: grammage 40–70 g/m^2 , Hunter gloss 45–55%, PPS S10 roughness 1.5–2.0 μm , density 1000–1050 kg/m^3 , brightness 70–75% and opacity 91–95%.

15 As general values for MWC paper (medium weight coated) may be regarded the following: grammage 70–90 g/m^2 , Hunter gloss 65–75%, PPS S10 roughness 0.6–1.0 μm , density 1150–1250 kg/m^3 , brightness 70–75%, and opacity 89–94%.

20 HWC (heavy weight coated) has a grammage of 100–135 g/m^2 and it can be coated even more than twice.

Woodfree printing papers made of chemical pulp, or fine papers, include uncoated and coated chemical-pulp based printing papers, in which the proportion of mechanical pulp is less than 10%.

25 Uncoated chemical-pulp based printing papers (WFU) contain 55–80% bleached birchwood pulp, 0–30% bleached softwood pulp, and 10–30% fillers. With WFU, the values vary considerably: grammage 50–90 g/m^2 (up to 240 g/m^2), Bendtsen roughness 250–400 ml/min , brightness 86–92% and
30 opacity 83–98%.

In coated chemical-pulp based printing papers (WFC), the amounts of coating vary greatly in accordance with the requirements and intended use. The following are typical values for once and twice coated chemical-pulp based printing paper: grammage of once coated 90 g/m², Hunter gloss 65-80%, PPS s10 roughness 0.75-2.2 µm, brightness 80-88%, and opacity 91-94%, and grammage of twice coated 130 g/m², Hunter gloss 70-80%, PPS S10 roughness 0.65-0.95 µm, brightness 83-90% and opacity 95-97%.

Release papers have a grammage ranging from 25 to 150 g/m².

10

Other papers include packing papers (Sackkraft), tissues, and wallpaper bases.

Boards constitute a fairly heterogeneous group which includes grades having a high grammage of up to 500 g/m² and grades having a low grammage of about 120 g/m², the grades ranging from ones based on virgin fibre to 100% recycled fibre based grades, and from uncoated to multiply coated. In the following, board grades are divided into coated and uncoated grades because coating has the greatest effect on the calendering method. In coated grades, both precalendering before the coating machine and the final calender after the coating machine are used. Uncoated grades are only subjected to final calendering. These two groups include several board grades as follows:

25 Coated board:

- virgin fibre based (folding boxboard (FBB), bleached pulp board (SBS = solid bleached board), liquid packaging board (LPB), coated white top liner, carrier board)
- recycled fibre based (white-lined chipboard (WLC), coated recycled board).

30

Uncoated board:

- virgin fibre based (kraft liner, white top liner, liquid packaging board)

- recycled fibre based (test liner)

In the following are described calendering concepts for different coated board grades such as folding boxboard, white-lined chipboard, solid bleached board and liquid packaging board. Coated board grades vary from one-layer to five-layer board. The most important qualities are large bulk, rigidity and smoothness. The board is often one-sided, but may also be two-sided (SBB boards).

10 Precalendering is applied before the coating machine to reduce roughness and porosity to a target level characteristic of the coating machine. The precalendering method is dependent on many variables, the most important being the following:

- 15
- the structure of the board machine (Yankee cylinder)
 - raw materials (virgin fibre versus recycled fibre; European fibre versus fibre from the southern part of the USA).

Precalendering mainly serves the purpose of CD-direction calibre control when there is a Yankee cylinder in the board machine (typically a folding boxboard machine). The Yankee cylinder produces an extremely smooth surface with large bulk. Precalendering is usually done with one hard-nip calender, based on either thermal or hydraulic calibre control. Line loads are typically fairly low, 10-30 kN/m, and thermo roll temperatures 70-100°C.

25

Typical board grades made without a Yankee cylinder are solid bleached board, white lined chipboard, coated recycled board and liquid packaging board.

30 Traditionally, precalendering was carried out by using a multi-roll hard-nip calender and the calendering effect was enhanced by adding water by means of water boxes (wet stack calenders). The number of rolls varies from 4 to

11 depending on the board grade; the more readily calendered European fibres do not require as many nips as fibres originating from the southern part of the USA. Recycled fibres are likewise more readily calendered than virgin fibres.

5

The ability to raise the temperature of the thermo roll has shifted precalendering towards hot calendering. Today, the aim is to use hot hard nip calendering or soft calendering. Increased thermo roll temperatures (even exceeding 200 °C) result in bulk savings due to the temperature
10 gradient. The runnability of a hot hard nip calender or soft calender is better than that of a multi-roll hard nip calender. Likewise the application of water on wet stack calenders is not easy to control.

Uncoated board grades often have only one or two layers. Multi-layered,
15 uncoated boards, such as liquid packaging boards, can also be produced. As with coated boards, the calendering of uncoated boards should also save on bulk and rigidity.

With some grades, such as fluting and certain untreated test liner grades,
20 calendering is not required. Traditionally, calendering was almost always carried out on hard nip calenders. The display and advertising function of fluted packages has recently become increasingly important. This has increased demands for a higher-quality, bleached surface layer. Soft calenders are, therefore, used also for uncoated board grades when good
25 printability is required. Steam-jet sprayers may be used before the calender to improve the outcome of calendering if the board is cooled.

The future trend, as with coated grades, is toward long nip calendering.

30 The aim of the present invention is to provide for as optimal as possible calendaring of a fibrous board, which is preferably composed of at least one of the foregoing paper and board grades, to higher formation scale

roughness and bulk with lower micro-level roughness (PPS) and improved printing properties.

To achieve this aim, the method according to the present invention is
5 characterised in that in order to humidify the fibrous web, the humidifying agent is supplied on the surface of the fibrous web 0.2-4 seconds before conveying it to the processing zone, and that 0.01-10 grams of humidifying agent per square metre is supplied, whereby subsequent to passing through the processing zone, the bulk of the fibrous web is greater than $1.40 \text{ cm}^3/\text{g}$
10 and the PPs roughness is 2-6 μm .

Furthermore, it is characteristic of the device implementing the method according to the invention that the means for humidifying the fibrous web are located at such point before the processing zone in the direction of travel
15 of the fibrous web, where the humidifying agent can be supplied on the surface of the fibrous web 0.2-4 seconds before conveying it to the processing zone, and that the means for humidifying the fibrous web are arranged to supply 0.01-10 grams of humidifying agent per square metre, whereby subsequent to passing through the processing zone, the bulk of the
20 fibrous web is greater than $1.40 \text{ cm}^3/\text{g}$ and the PPs roughness is 2-6 μm .

By means of the above-mentioned method are achieved the foregoing aims for improving the properties. The advantage of this is, for example, a significant improvement of the end product.
25

Preferred embodiments of the present invention are disclosed in the dependent claims.

The invention is described in greater detail in the following, with reference to
30 the accompanying drawings, in which:

Figure 1 shows the device for implementing the method according to the invention in an exemplary manner, and

5 Figure 2 shows a diagram of the changes in the surface roughness and bulk of unhumidified and humidified folding boxboard in connection with calendaring.

Figure 1 shows a device according to the invention implemented as a belt calendar comprising a calendaring belt 2 made of metal which rotates around guide rolls 3, of which guide rolls at least one is movable for adjusting the belt 2 tension as desired. The calendaring belt 2 travels around a roll 5 arranged outside of it, whereby a calendaring zone is formed between the belt 2 and the roll 5. The material web W to be calendered passes through the calendaring zone, whereupon it is subjected to the desired pressure impulse and thermal effect as a function of time. Figure 1 illustrates by a dot-and-dash line 9 the shape of the pressure impulse when a nip roll 4 acting as a pressing means is arranged inside the calendaring belt 2, the said roll pressing the belt against the roll 5, thus forming a higher-pressure nip zone within the calendaring zone. Dash line 8, for its part, illustrates the shape of the pressure impulse when the contact pressure acting in the calendaring zone is created only by means of the belt 2 tension, when the nip roll 4 is out of pressing contact with the belt 2 (or when no nip roll 4 is not mounted inside the belt 2). It is understandable from this that the arrangement forms a so-called long nip. The roll 5, like the nip roll 4, may or may not be a deflection-compensated roll and it is selected from a group including a flexible surface roll, such as a polymer-coated roll, a rubber-coated roll or an elastomer-surface roll, a shoe roll, a thermo roll and a fibre roll. In the embodiment shown in Figure 1, the nip roll is a shoe roll. Reference numeral 6 represents heating means, such as an induction heater, an infrared radiator, a gas burner or a capacitive heater. In the solution relating to the invention, especially when using a metal belt, may be used elevated temperatures, for example from higher than about 100 °C to higher

than about 200 °C and even up to about 400 °C, depending on the application. An elevated temperature together with a long application time and an extensive pressure regulation range yields a good calendaring result at both high and low speeds, for example, speeds ranging from 100 m/min
5 to 4000 m/min.

To enhance calendaring according to the invention, the web is humidified in the direction of travel of the web at a point preceding the processing zone. For this purpose, a humidifier 7 is provided in the vicinity of the fibrous web
10 for spreading the humidifying agent on the surface of the fibrous web. The humidifying agent is usually water (water vapour or mist). Depending on the type of web, 0.01-10 grams of humidifying agent per square meter is spread on the surface of the web. Furthermore, the humidifying agent is spread on the surface of the web timewise 0.2-4 seconds before the said point reaches
15 the processing zone. The said time is also partly dependent on the type of the fibrous web. It is also obvious that the humidifier 7 may be out of use, in which case no humidifying agent is spread on the surface of the fibrous web.

The length and/or overall pressure of the processing zone may be adjusted
20 with respect to the feed time and/or volume of humidifying agent.

As an example may be presented a test measurement carried out by the Applicant on uncoated folding boxboard, where the arrangement corresponded to the arrangement according to Figure 1, where the roll 5 was
25 a thermo roll and a nip roll 4 was not in use for creating enhanced pressure. The temperature of the thermo roll surface was about 170 °C and that of the backside metal belt about 80 °C. The humidifying agent was spread on the surface of the material web W on the thermo roll side, where the measurements were carried out.

30

Without humidification, a PPS roughness of about 5.7-8.1 µm was typically obtained (the nip pressures being 3-9 MPa), but with humidity values of 2-6

g/m² (with a constant pressure of 5 MPa), the PPS roughnesses were about 5.5-6.5 µm. This is illustrated in Figure 2. Figure 2 shows a diagram in which curve 10 represents the measurement results without humidification. Point 10a corresponds to a press nip pressure of 3 MPa, 10b a pressure of 6 MPa and point 10c a pressure of 9 MPa. Curve 11 represents calendering carried out at a constant 5 MPa pressure of the press nip, with humidification. Point 11a corresponds to a humidification value of 0 g/m², point 11b a humidification value of 2 g/m², point 11c a humidification value of 3 g/m², point 11d a humidification value of 4 g/m², point 11e a humidification value of 6 g/m². The diagram clearly shows an advantageous lessening of roughness when the surface of the web is humidified in accordance with the method. It should be noted that the square outlined in bold in the diagram is a target zone within which the bulk and the PPS roughness value should desirably be after calendering. It can be seen that by means of humidification, both the PPS roughness and the bulk will fall within this zone. The target value for pulp is greater than 1.40 cm³/g and the target for PPs roughness is 2-6 µm.

The tests carried out by the Applicant also show a clear improvement in the Bendtsen roughness of the board grade in question on the thermo roll side.

It is conceivable to use humidification instead of pressure adjustment (adjustment of the metal belt tension), nip length adjustment or temperature regulation for obtaining the PPS roughness. The test was also carried out without a backing roll, which makes it conceivable that the method is applicable to improving smoothness (however so that the large bulk is maintained) without a backing roll, at least with some fibrous web grades. It is also conceivable to reduce the nip load and/or the temperature, while maintaining the quality. This in turn reduces the stress on the machinery, thus increasing their service life or replacement/service interval.

The present invention is not only limited to the embodiment described above, but it may be applied in many ways within the sphere of protection limited by the claims. Humidification, for example, may be carried out on both sides of the web W and the temperatures used on the surfaces of the thermo roll and the metal belt may vary considerably depending on the type of material.

5

Claims

1. A method for handling a fibrous web (W) in a metal belt calender (1), in which method an endless metal belt (2) is arranged to rotate around a guide means (3) and to form a processing zone with a counter-element (5) provided outside the metal belt (2), and in which the fibrous web (W) is humidified at least on one side before passing it through the processing zone, **characterised** in that in order to humidify the fibrous web (W), the humidifying agent is supplied on the surface of the fibrous web (W) 0.2-4 seconds before conveying it to the processing zone, and that 0.01-10 grams of humidifying agent per square metre is supplied, whereby subsequent to passing through the processing zone, the bulk of the fibrous web (W) is greater than 1.40 cm³/g and the PPs roughness is 2-6 µm.
2. A method as claimed in claim 1, **characterised** in that the humidifying agent is spread at least on that side of the fibrous web (W), the surface of which is towards the counter-element (5) in the processing zone.
3. A method as claimed in claim 1 or 2, **characterised** in that the length and/or overall pressure of the processing zone is adjusted with respect to the feed time and/or volume of humidifying agent.
4. A device for handling a fibrous web (W) in a metal belt calender (1), in which device an endless metal belt (2) is arranged to rotate around a guide means (3) and to form a processing zone with a counter-element (5) provided outside the metal belt (2), and which device includes means (7) for humidifying the fibrous web (W) at least on one side before passing it through the processing zone, **characterised** in that the means (7) for humidifying the fibrous web (W) are located at such point before the processing zone in the direction of travel of the fibrous web, where the humidifying agent can be supplied on the surface of the fibrous web (W) 0.2-4 seconds before conveying it to the processing zone, and that the means for

humidifying the fibrous web (W) are arranged to supply 0.01-10 grams of humidifying agent per square metre, whereby subsequent to passing through the processing zone, the bulk of the fibrous web is greater than 1.40 cm³/g and the PPs roughness is 2-6 µm.

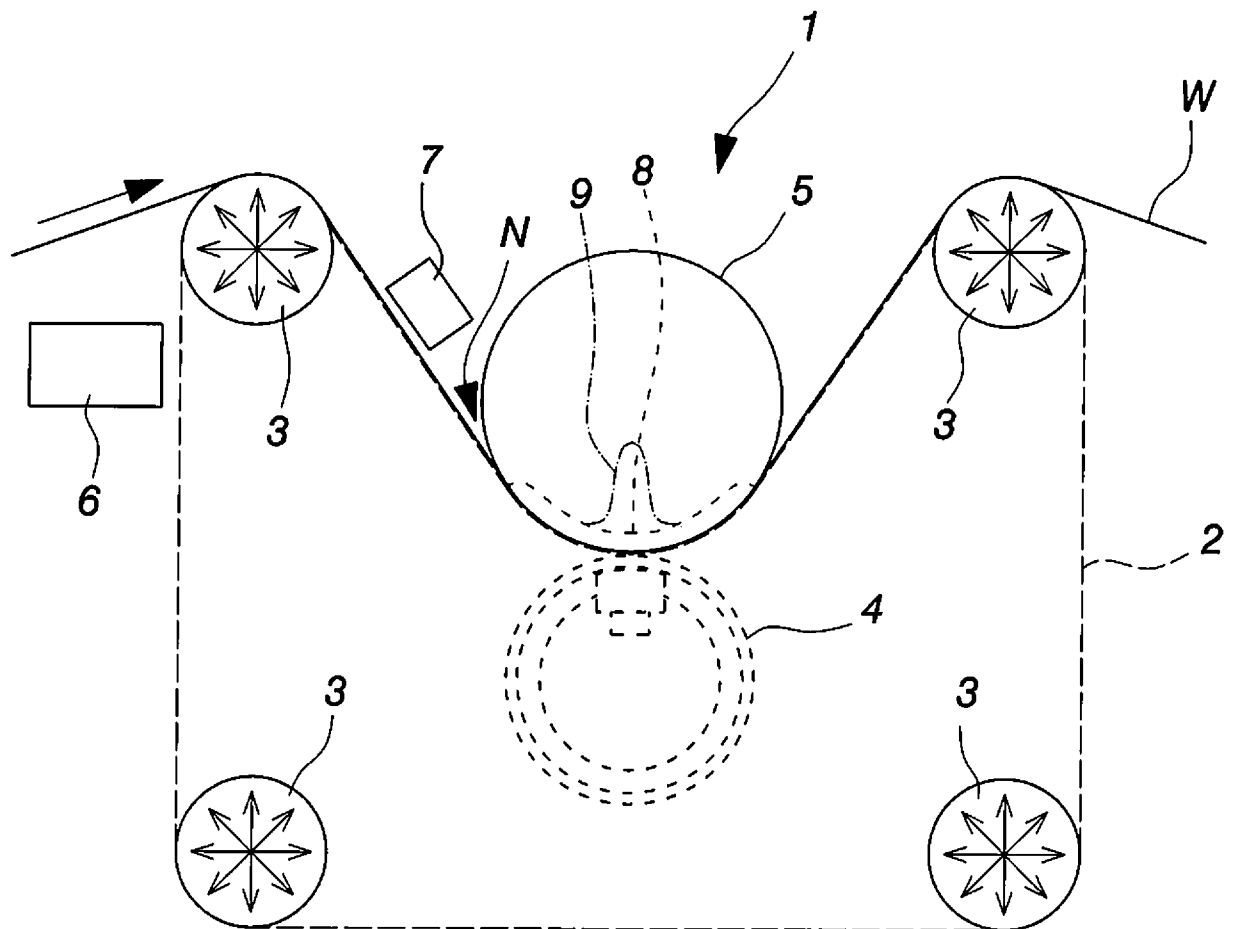


Fig. 1

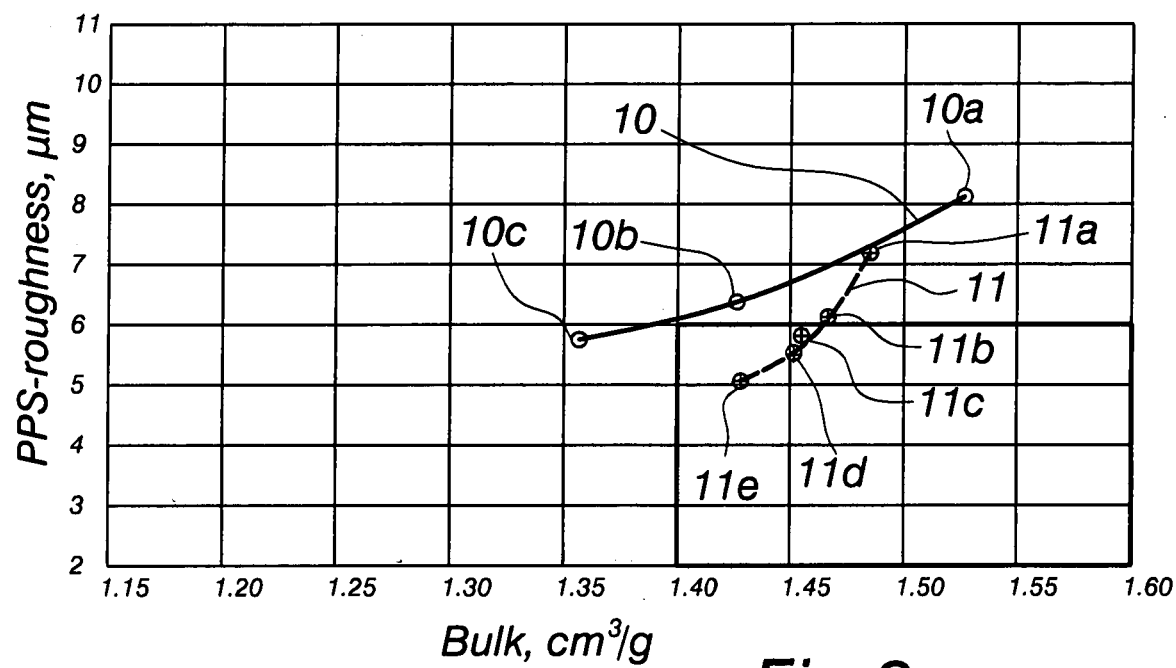


Fig.2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2009/050433

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D21G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI, XPESP, COMPDX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FI 116980 B (METSO PAPER INC) 28 April 2006 (28.04.2006), page 3, line 35-page 4, line 9, page 6, line 22-page 7, line 27, claims 1-2, fig. 5	1-4
A	FI 102305 B (VALMET CORPORATION) 13 November 1998 (13.11.1998), page 8, line 24-page 16, line 12, fig. 1	

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

03 August 2009 (03.08.2009)

Date of mailing of the international search report

04 August 2009 (04.08.2009)

Name and mailing address of the ISA/FI
National Board of Patents and Registration of Finland
P.O. Box 1160, FI-00101 HELSINKI, Finland

Facsimile No. +358 9 6939 5328

Authorized officer

Mari Ylönen

Telephone No. +358 9 6939 500

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2009/050433

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
FI 116980 B	28/04/2006	WO 2005042837 A1	12/05/2005
.....			
FI 102305 B	13/11/1998	US 6397739 B1	04/06/2002
		JP 2001518150T T	09/10/2001
		WO 9844196 A1	08/10/1998
		EP 0973972 A1	26/01/2000
		DE 69803049T T2	20/06/2002
		CA 2285301 A1	08/10/1998
		AU 6503798 A	22/10/1998
		AT 211197T T	15/01/2002
.....			

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2009/050433

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.
D21G 1/00 (2006.01)